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DEVELOPMENT OF FORAGE OAT AND BARLEY CULTIVARS WITH IMPROVED NUTRITIVE VALUE

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Final Report
Project 2006-0123
Development of forage oat and barley cultivars with improved nutritive value
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Summary: The goal of this study was to improve the forage nutritive value and productivity of forage barley and oats. Trials were seeded in Saskatoon (AAFC and Kernen) and Melfort from 2007-09 and harvested for dry matter and sampled for forage quality. On the basis on results in 2007 and 2008, two lines of forage barley were entered into the Western Coop Forage Barley Test. They were the highest yielding lines in the test being 12-14% higher yielding than the checks. Several promising forage oat lines were also identified and will be considered for release.

Introduction:

Barley, and to a lesser extent, oat are important annual forage crops used in Saskatchewan for silage, green feed and swath grazing (Klein, 2002). Barley is more widely used because of higher forage quality than oat (Aasen et al. 2004; Khorasani et al. 1997) mainly due to higher NDF and ADF in the latter. However, oat is often higher yielding than barley in moister environments.

Barley and oats have been generally selected for grain yield and quality so ADF and NDF determinations on whole plant material have seldom been done. Therrien (2003) found the heritability for these fiber fractions to be relatively low, and emphasized the need to select for these traits over more than one environment. Another desirable forage trait in barley is the smooth awn characteristic to prevent mouth lesions.

Recent developments in the oat and barley breeding programs at the Crop Development Centre (CDC), have the potential to significantly improve the quality of forage oat and barley. Incorporation of the recently identified low acid detergent lignin hull trait would lower the acid-detergent fiber and raise the total digestible nutrient % (%TDN) of oat. Incorporation of the fine stemmed characteristic of AC Marie into the standard forage oat cultivar, CDC Baler, could also result in improvements in TDN. Appropriate crosses have been made and advanced breeding lines are available to evaluate for forage yield and quality.

CDC Cowboy is a recently released forage barley and crosses have been made with smooth awned cultivars to produce a smooth awned version of this cultivar. Advanced lines are also available in which to select the best forage types.

This project specifically evaluated advanced lines for forage yield and quality and will lead to the development of improved cultivars for forage purposes.

Methods

Four different trials (two barley and two oat) were seeded at three locations over three years with a variable number of lines in each trial (Table 1A). Trials included experimental lines and appropriate check cultivars. Several check cultivars were

included but for comparison of experimental lines the check cultivars were CDC Cowboy for barley and CDC Baler for oat. The designation and pedigrees of the experimental lines can be found in the data tables (Tables 1-12).

- Design of experiments:

  Randomized complete block - three replicates

  Plots were 1.2 X 4.0 or 6.0 m depending on location

  Check cultivars: CDC Baler (oat) and CDC Cowboy (barley)

- Data collected:

  Forage dry matter yield - the entire plot cut and weighed with a Hege or Haldrup harvester and a sub sample taken for dry matter analysis

  ADF, NDF and CP - The subsample taken at harvest was dried and ground and used for laboratory analyses.

  Number of days to heading.

  Evaluation of awns (barley)

- Deviations from original work plan:

  1. Different numbers and types of advanced breeding lines – Lines tested were based on availability. Additional lines were added as they became available from the breeding program.
  2. Locations: Two sites in Saskatoon (AAFC and Kernen) were used instead of one as proposed in the original plan. This provides an adequate number of sites for lines to be considered for entry into the Western Forage Barley Coop.
  3. An additional year of testing (2009) was added to the project as approved by Henry Soita of ADF.

Results:

Dry matter yield and forage quality data from the three years are presented in Tables 1-12. The 2009 data from the Western Forage Barley Cooperative Test are in Table 13. The Preliminary Forage trials had lines that were not as advanced (F6), while the Regular Trials had lines that were more advanced (F7 or higher) and had been previously tested.

2007: The forage barley trial (Table 1) had mainly lines from crosses with AC Ranger and CDC Cowboy as parents. No lines exceeded CDC Cowboy in yield but **SB041385** was equal and showed a lower NDF concentration. The Preliminary trial (Table 2) had CDC McGwire/AC Bacon populations which were low yielding and lines from CDC Cowboy crosses, of which **SB060176** was higher yielding than CDC Cowboy, but only similar in quality. Both lines were advanced and are now in the Forage Barley Coop.

In the forage oat trial (Table 3), almost all experimental lines came from crosses with CDC Baler. A few lines were slightly higher yielding than CDC Baler and a few had lower fibre. The highest forage yield lines in the trial were the grain cultivars, **CDC Weaver** and Jordan. **SA04412** was slightly higher yielding than CDC Baler and was

retained for further testing and breeder seed purification hills have been grown in 2009/10 in New Zealand. In the Preliminary trial (Table 4), consisting of lines from crosses of CDC Baler and either AC Marie or AC Assiniboia, several lines outyielded CDC Baler, but few were superior in quality. **SA060047** and **SA060078** were superior in both characteristics. In addition, **CDC Weaver** was 12% higher yielding and lower in fibre than CDC Baler.

2008: In the Forage Barley trial (Table 5), most lines were from crosses with CDC Cowboy. All lines, with the exception of SB070739, were inferior in yield to CDC Cowboy, and were similar, or lower, in quality. The Preliminary trial (Table 6) had lines from crosses with either AC Ranger or CDC Cowboy and the only promising line was **SB060176** which was also identified in the 2005 trial and is now in the Forage Barley Coop.

In the Forage Oat Trial (Table 7), all lines were from crosses with CDC Baler and a few were slightly higher yielding than CDC Baler. **SA060072** was both higher yielding and substantially lower in fibre, while **SA060078**, which was identified as promising in 2007, was lower in fibre, than CDC Baler. **SA060072** was advanced to Breeder Seed purification hills in 2009/10 in New Zealand. The Preliminary Trial (Table 8) had all lines from the CDC Baler/Buffalo (a winter oat from the UK) cross, and were generally inferior to CDC Baler in yield. In both oat trials, CDC Weaver was higher in yield and lower in fibre than CDC Baler, despite its more advanced maturity when the trial was cut. CDC Weaver headed about six days earlier than CDC Baler.

2009: In the Forage Barley trial (Table 9) all four experimental lines outyielded CDC Cowboy. **SB041385** and **SB060176** were also lower in fibre than CDC Cowboy. In the Preliminary Trial (Table 10), consisting of lines from the cross CDC Cowboy/TR02185, there were many lines which were both considerably higher yielding and lower in fibre than CDC Cowboy, but all were rough awned like CDC Cowboy.

In the Forage Oat Trial (Table 11), there were several lines which were higher yielding than CDC Baler, including **SO04551** and **SA060078**, which were also considerably lower in fibre than CDC Baler. The latter was about three days earlier in maturity than CDC Baler. The Preliminary Trial (Table 12) consisted of lines from the cross CDC Weaver/CDC Baler. These crosses were made following data from previous trials showing the excellent yield and low fibre concentration of CDC Weaver. CDC Weaver also performed well in every year of trials in this project. There were many high yielding experimental lines in the Preliminary Trial, including SA080047, which was 37% higher yielding than CDC Baler. It should be noted, however, that forage yield data was available for this trial only from Melfort. A number of the lines were also lower in fibre than CDC Baler.

The barley lines **SB041385** (FB204) and **SB060176** (FB205) were entered into the six site Western Forage Barley Cooperative Test in 2009 (Table 13). These lines outyielded the check cultivar Virden by 13 and 10% respectively, the only lines in the trial to do so. They were similar in fibre concentration to Virden. SB041385 and SB060176 both have CDC Cowboy in their pedigrees and the first is semi-smooth awned and the latter smooth awned. If these lines continue to perform well in the 2010 Coop test, we will register one or both as new forage barley cultivars.

Based on the 2007 and 2008 data, oat lines **SA04412** and **SA060072** were increased in 2009 with 100 panicles taken from each to produce Breeder Seed purification hills in the CDC 2009/10 New Zealand winter nursery. Seed from these New Zealand hill plots is available for final Breeder Seed purification and first bulk Breeder Seed production during 2010, with possible release as cultivars in 2011. However, based on 2009 quality data from analyses completed during the 2009/10 winter, **SO04551** and **SA060078** (a full-sister to **SA060072**) may if fact be superior selections. As a result, final Breeder Seed purification for **SA04412** and **SA060072 may** be delayed until 2011. Further evaluation of these four lines will be carried out during the 2010 growing season.

Conclusions:

The forage yield and quality evaluations carried out in this project identified several promising lines of forage oat and barley. These lines were:

1. **SB041385 barley** – semi-smooth awned 2 row, entered into 2009 Forage Barley Coop, where it outyielded the check by 13%.
2. **SB060176 barley** – smooth awned 2-row, entered into 2009 Forage Barley Coop, where it outyielded the check by 10%.
3. **CDC Weaver oat** – a registered oat grain cultivar which consistently had higher forage yield and lower fibre than the check cultivar CDC Baler.
4. **SA04412 oat** - This line, which came from a cross between CDC Baler and CDC Dancer, had higher yields than CDC Baler in the 2007-2009 trials.
5. **SA060072 oat** - This line, which came from a cross between CDC Baler and AC Assiniboia, had higher yields and lower fibre than CDC Baler in two of three years of trials.
6. **SA60078 oat** – This line, which came from a cross between CDC Baler and AC Assiniboia, had consistently higher yields and lower fibre than CDC Baler.
7. **SO04551 oat** - This line, which came from a cross between CDC Baler and AC Assiniboia, had higher yields and lower fibre than CDC Baler in the 2008 and 2009 trials.
8. Several very high yielding lines from crosses of CDC Baler and CDC Weaver were identified in the 2009 trials; however, these were from a single site.
9. This moderate forage oat and barley breeding effort has resulted in significant improvement in forage yield and quality in the CDC forage germplasm.

The lines from crosses of CDC Baler and AC Assiniboia were not consistently lower in fibre; thus the low acid detergent lignin hull of AC Assiniboia did not provide lower fibre in all progeny. However, three of the four promising oat lines, mentioned above, came from this cross.

Recommendations:

1. If **SB041385** and **SB060176** barley continue to show a significant forage yield improvement over the check in the 2010 Coop trial, register and release one or

both of them as new cultivars, and license production and marketing to a member of the Canadian seed industry.

2. Include **CDC Weaver** as a cultivar of oat recommended for forage purposes.
3. Test **SO04551, SA060078, SA04412** and **SA060072** oats at three sites in 2010. One or two lines that continue to show significantly higher forage yield and lower fibre than CDC Baler will be released as new cultivar(s) and licensed to a member(s) of the Canadian seed industry.
4. The many high yielding, low fibre oat and barley lines identified in the 2009 Preliminary Trials should be tested at the three locations for another two years

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Various field days were held at the Kernen Crop Research Farm from 2007-09 and the trials in this project were visited and described. The funding of the Ministry of Agriculture was acknowledged in the trial descriptions.

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Appendices: Tables 1A and 1-13 are included in a separate excel file.

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Table 1A. Number of lines tested by Year and Location

Trial	Year	Location	Number of lines
Preliminary Forage Oat	2007	Melfort	36
		Stoon Kernen	36
	2008	Melfort	10
		Stoon Kernen	10
	2009	Melfort	16
		Stoon Kernen	16
Preliminary Forage Barley	2007	Melfort	12
		Stoon Kernen	12
	2008	Melfort	16
		Stoon Kernen	16
	2009	Melfort	16
		Stoon Kernen	16
Forage Oat	2007	Melfort	30
		Stoon Kernen	30
		Stoon AAFC	30
	2008	Melfort	16
		Stoon Kernen	16
		Stoon AAFC	16
	2009	Melfort	10
		Stoon Kernen	10
		Stoon AAFC	10
Forage Barley	2007	Melfort	10
		Stoon Kernen	10
		Stoon AAFC	10
	2008	Melfort	8
		Stoon Kernen	8
		Stoon AAFC	8
	2009	Melfort	8
		Stoon Kernen	8
		Stoon AAFC	8

Table 13
Western Forage Barley Cooperative Test - 2009

Ent#	Entry	Days to Head	Height	Forage DM Yld	% Virden	Forage Quality CP	ADF	NDF
1	Virden	57.2	82.4	9303.7	100	8.6	32.5	51.4
2	Stockford	57.1	74.7	8790.0	94	9.2	31.5	51.0
3	AC Ranger	55.4	74.2	8951.0	96	9.2	30.9	51.7
4	Vivar	56.2	69.7	9135.2	98	9.3	30.6	51.0
5	FB315	58.7	79.3	8811.3	95	9.3	32.7	52.3
6	FB316	59.6	81.0	8843.8	95	9.0	32.2	52.2
7	FB317	60.3	77.2	9349.3	100	9.2	32.3	53.6
8	FB424	55.7	69.1	8418.6	90	9.0	30.0	50.1
9	FB015	53.3	91.6	9272.0	100	8.7	30.3	50.7
10	FB204*	57.1	91.3	10529.6	113	9.5	32.5	51.7
11	FB205**	56.3	91.9	10207.3	110	8.5	31.6	52.3
12	FB426	53.1	78.3	8941.0	96	9.0	31.4	53.3
13	FB427	55.6	68.2	9236.0	99	8.6	30.4	50.6
14	FB428	54.0	72.9	8984.5	97	8.3	31.4	51.4
	Mean	56.4	78.7	9198.1		9.0	31.5	51.7
	Std.Error	2.3	10.0	927.2		0.7	1.7	2.3
	CV	4.0	12.8	11.0		8.3	5.6	4.5
	Site-Yrs	**3**	**6**	**6**		**5**	**5**	**5**

* SB041385 Ranger/SB97590

** SB060176 Falcon/SB93964//CDC Cowboy